CLAIM AMENDMENTS

Please amend the claims as follows:

1-56. (Cancelled)

57. (New) An optical multi/demultiplexing circuit with a phase generating function, where the optical multi/demultiplexing circuit multi/demultiplexes a plurality of optical signals in a whole passband, the whole passband being configured with a plurality of passbands, the plurality of passbands being arranged on a wavelength-domain grid or an optical frequency-domain grid, centers of each of the plurality of passbands being located on the wavelength-domain grid or the optical frequency-domain grid, the optical multi/demultiplexing circuit comprising:

one or more optical multi/demultiplexing devices including at least one input section and a plurality of output sections; and

at least one optical delay line device interposed between each of the optical multi/demultiplexing devices,

at least one of the optical multi/demultiplexing devices or the optical delay line devices including a phase generating device wherein

the phase generating device generates a wavelength-dependent or optical frequency-dependent phase Φ with respect to a wavelength or optical frequency of light over the whole passband of the optical multi/demultiplexing circuit, the phase Φ setting a wavelength period between the centers of the adjacent passbands which are located on the wavelength-domain grid or setting an optical frequency period between the centers of the adjacent passbands which are located on the optical frequency-domain grid, respectively.

58. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein the wavelength period is uniform with respect to wavelength.

59. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein the optical frequency period is uniform with respect to optical frequency period, and at the same time, a center frequency of one of the passbands of the optical multi/demultiplexing circuit located near the center of the whole passband is set to a desired value on the optical frequency-domain grid.

60. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein a transmission characteristic of the optical multi/demultiplexing circuit in the whole passband is given by an equation as follows:

$$X(\lambda) = \sum_{q=0}^{N} x_q \exp\left\{ -j2\pi q \left[\frac{\Delta L'}{\lambda} - \Psi(\lambda) \right] \right\}$$

where N represents the order of the optical multi/demultiplexing circuit, x_q represents the expansion coefficients, λ represents a wavelength, Ψ(λ) represents a target wavelength-dependent phase which is required to set the wavelength period between the centers of the adjacent passbands on the wavelength-domain grid, and ΔL'(=ΔL+δL) represents the optical path length difference of the optical delay line device including wavelength-dependent refractive index, where ΔL is a fixed value and δL is a minute optical path length difference, which is a variable changed according to the design of the phase generating device, and

wherein the wavelength-dependent phase Φ generated by the phase generating device is equal to the target wavelength-dependent phase Ψ(λ).

61. (New) The optical multi/demultiplexing circuit as claimed in claim 60, wherein the wavelength period is uniform with respect to wavelength.

62. (New) The optical multi/demultiplexing circuit as claimed in claim 61, wherein the wavelength-dependent phase Φ generated by the phase generating device is given by a function of a wavelength (λ) of light in the whole passband of the optical multi/demultiplexing circuit, and wherein the functions are a polynomial consisting of a quadratic or higher order function, and the target wavelength-dependent phase $\Psi(\lambda)$ is given by an equation as follows:

$$\Psi(\lambda) = \frac{(\Delta L + \delta L)}{\lambda} + \frac{\lambda}{\Delta\lambda} - \left(m + \frac{\lambda_c}{\Delta\lambda}\right)$$

where $\Delta\lambda$ represents the wavelength period of the optical multi/demultiplexing circuit on the wavelength-domain grid, λ_c represents a center wavelength of one of the passbands of the optical multi/demultiplexing circuit located near the center of the whole passband, and m represents an integer.

63. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein a transmission characteristic of the optical multi/demultiplexing circuit in the whole passband is given by an equation as follows:

$$X(f) = \sum_{q=0}^{N} x_q \exp\left\{-j2\pi q\left[\frac{n\Delta L'}{c}f - \Psi(f)\right]\right\}$$

where N represents the order of the optical multi/demultiplexing circuit, x_q represents the expansion coefficients, n represents a frequency-dependent refractive index, c represents the speed of the light, f represents an optical frequency, $\Psi(f)$ represents a target optical frequency-dependent phase which is required to set the optical frequency period between the centers of the adjacent passbands on the optical frequency-domain grid, and $\Delta L'(=\Delta L+\delta L)$ represents the path length difference of the optical delay line device, where ΔL is a fixed value and δL is a minute optical path length difference, which is a variable changed according to the design of the phase generating device,

and wherein the optical frequency-dependent phase Φ generated by the phase generating device is equal to the target optical frequency-dependent phase $\Psi(f)$.

64. (New) The optical multi/demultiplexing circuit as claimed in claim 63, wherein the optical frequency period is uniform with respect to optical frequency period, and at the same time, a center frequency of one of the passbands of the optical multi/demultiplexing circuit located near the center of the whole passband is set to a desired value on the optical frequency-domain grid.

65. (New) The optical multi/demultiplexing circuit as claimed in claim 64, wherein the optical frequency-dependent phase Φ generated by the phase generating device is given by a function of an optical frequency (f) of light in the whole passband of the optical multi/demultiplexing circuit, and wherein the functions are a polynomial consisting of a quadratic or higher order function, and the target optical frequency-dependent phase $\Psi(f)$ is given by an equation as follows:

$$\Psi(f)=\left[\frac{n(\Delta L+\delta L)}{c}-\frac{1}{\Delta f}\right]f-\left(m_c-\frac{f_c}{\Delta f}\right)$$

where Δf represents the optical frequency period of the optical multi/demultiplexing circuit on the optical frequency-domain grid, f_c represents a center optical frequency of one of the passbands of the optical multi/demultiplexing circuit located near the center of the whole passband, and m_c represents an integer.

66. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two,

and wherein the wavelength-dependent phase Φ is generated by appropriately setting respective coupling ratios of the optical couplers and respective optical path length differences of the optical delay lines.

67. (New) The optical multi/demultiplexing circuit as claimed in claim 58, wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two,

and wherein the wavelength-dependent phase Φ is generated by appropriately setting respective coupling ratios of the optical couplers and respective optical path length differences of the optical delay lines.

68. (New) The optical multi/demultiplexing circuit as claimed in claim 59, wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two,

and wherein the wavelength-dependent phase Φ is generated by appropriately setting respective coupling ratios of the optical couplers and respective optical path length differences of the optical delay lines.

69. (New) The optical multi/demultiplexing circuit as claimed in claim 60, wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two,

and wherein respective coupling ratios of the optical couplers, respective optical path length differences of the optical delay lines, and the minute optical path length difference δL are appropriately set such that the wavelength-dependent phase Φ is equal to the target wavelength-dependent phase $\Psi(\lambda)$.

70. (New) The optical multi/demultiplexing circuit as claimed in claim 63, wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two,

and wherein respective coupling ratios of the optical couplers, respective optical path length differences of the optical delay lines, and the minute optical path length difference δL are appropriately set such that the optical frequency-dependent phase Φ is equal to the target optical frequency-dependent phase $\Psi(f)$.

71. (New) The optical multi/demultiplexing circuit as claimed in claim 58, wherein the optical multi/demultiplexing circuit consists of an optical interferometer, and wherein

the optical interferometer comprises (N + 1) optical multi/demultiplexing devices, and N optical delay line devices interposed between adjacent two of the optical multi/demultiplexing devices, where N is an integer equal to or greater than one.

72. (New) The optical multi/demultiplexing circuit as claimed in claim 59, wherein the optical multi/demultiplexing circuit consists of an optical interferometer, and wherein

the optical interferometer comprises (N + 1) optical multi/demultiplexing devices, and N optical delay line devices interposed between adjacent two of the optical multi/demultiplexing devices, where N is an integer equal to or greater than one.

73. (New) The optical multi/demultiplexing circuit as claimed in claim 71, wherein the optical multi/demultiplexing circuit consists of a Mach-Zehnder interferometer including two of the optical multi/demultiplexing devices, the optical delay line device interposed between the two optical multi/demultiplexing devices, at least one input waveguide connected to one of the optical multi/demultiplexing devices, and at least one output waveguides connected to the other of the optical multi/demultiplexing devices, and wherein

the two optical multi/demultiplexing devices are disposed in left-right symmetry with respect to a middle line of the Mach-Zehnder interferometer;

the two optical multi/demultiplexing devices are a phase generating optical coupler which functions as a phase generating device; and

the phase generating optical coupler includes four optical couplers, and three optical delay lines each interposed between adjacent two of the optical couplers.

74. (New) The optical multi/demultiplexing circuit as claimed in claim 72, wherein the optical multi/demultiplexing circuit consists of a Mach-Zehnder interferometer including two of the optical multi/demultiplexing devices, the optical delay line device interposed between the two optical multi/demultiplexing devices, at least one input waveguide connected to one of the optical multi/demultiplexing devices, and at least one output waveguides connected to the other of the optical multi/demultiplexing devices, and wherein

the two optical multi/demultiplexing devices are disposed in left-right symmetry with respect to a middle line of the Mach-Zehnder interferometer;

the two optical multi/demultiplexing devices are a phase generating optical coupler, which functions as a phase generating device; and

the phase generating optical coupler includes four optical couplers, and three optical delay lines each interposed between adjacent two of the optical couplers.

75. (New) The optical multi/demultiplexing circuit as claimed in claim 71, wherein the optical multi/demultiplexing circuit consists of a Mach-Zehnder interferometer including two of the optical multi/demultiplexing devices, the optical delay line device interposed between the two optical multi/demultiplexing devices, at least one input waveguide connected to one of the optical multi/demultiplexing devices, and at least one output waveguides connected to the other of the optical multi/demultiplexing devices, and wherein

one of the two optical multi/demultiplexing devices is a phase generating optical coupler, which functions as a phase generating device; and

the phase generating optical coupler includes (M + 1) optical couplers, and M optical delay lines each interposed between adjacent two of the optical couplers, where M is an integer equal to or greater than two.

76. (New) The optical multi/demultiplexing circuit as claimed in claim 72, wherein the optical multi/demultiplexing circuit consists of a Mach-Zehnder interferometer including two of the optical multi/demultiplexing devices, the optical delay line device interposed between the two optical multi/demultiplexing devices, at least one input waveguide connected to one of the optical multi/demultiplexing devices, and at least one output waveguides connected to the other of the optical multi/demultiplexing devices, and wherein

one of the two optical multi/demultiplexing devices is a phase generating optical coupler which functions as a phase generating device; and

the phase generating optical coupler includes (M + 1) optical couplers, and M optical delay lines each interposed between adjacent two of the optical couplers, where M is an integer equal to or greater than two.

77. (New) The optical multi/demultiplexing circuit as claimed in claim 71, wherein the optical multi/demultiplexing circuit consists of a lattice-form filter including first, second, and third optical multi/demultiplexing devices, two optical delay line devices each interposed between adjacent two of the three optical multi/demultiplexing devices, at least one input waveguide connected to the first optical multi/demultiplexing device, and at least one output waveguide connected to the third optical multi/demultiplexing device, and wherein

the first and third optical multi/demultiplexing devices are a phase generating optical coupler, which functions as a phase generating device; and

the phase generating optical coupler includes (M + 1) optical couplers, and M optical delay lines each interposed between adjacent two of the optical couplers, where M is an integer equal to or greater than two.

78. (New) The optical multi/demultiplexing circuit as claimed in claim 72, wherein the optical multi/demultiplexing circuit consists of a lattice-form filter including first, second, and third optical multi/demultiplexing devices, two optical delay line devices each interposed between adjacent two of the three optical multi/demultiplexing devices, at least one input waveguide connected to the first optical multi/demultiplexing device, and at least one output waveguide connected to the third optical multi/demultiplexing device, and wherein

the first and third optical multi/demultiplexing devices are a phase generating optical coupler, which functions as a phase generating device; and

the phase generating optical coupler includes (M + 1) optical couplers, and M optical delay lines each interposed between adjacent two of the optical couplers, where M is an integer equal to or greater than two.

79. (New) The optical multi/demultiplexing circuit as claimed in claim 58, wherein the optical multi/demultiplexing circuit consists of a transversal-form filter.

80. (New) The optical multi/demultiplexing circuit as claimed in claim 59, wherein the optical multi/demultiplexing circuit consists of a transversal-form filter.

81. (New) The optical multi/demultiplexing circuit as claimed in claim 58, wherein a plurality of wave light output from the optical multi/demultiplexing device or a plurality of wave light input into the optical multi/demultiplexing device are launched into or emitted from at least one of a first slab waveguide or second slab waveguide included in an arrayed waveguide grating, wherein

the arrayed waveguide grating includes array waveguides having first ends connected to the first slab waveguide and second ends connected to the second slab waveguide.

82. (New) The optical multi/demultiplexing circuit as claimed in claim 81, wherein the optical multi/demultiplexing circuit comprises two of the optical multi/demultiplexing devices, and the optical delay line device comprises two optical delay lines disposed between the optical multi/demultiplexing devices, and wherein

one of the two optical multi/demultiplexing devices is connected to at least one of the input waveguides, and the other of the two optical multi/demultiplexing devices is connected to at least one of the first and the second slab waveguides of the arrayed waveguide grating.

83. (New) An optical multi/demultiplexing circuit comprising a first optical multi/demultiplexing circuit as defined in claim 71, and at least one second optical multi/demultiplexing circuit as defined in claim 71, the at least one second optical multi/demultiplexing circuit being connected to at least one of the outputs of the first optical multi/demultiplexing circuit.

84. (New) An optical multi/demultiplexing circuit comprising a first optical multi/demultiplexing circuit as defined in claim 72, and at least one second optical multi/demultiplexing circuit as defined in claim 72, the at least one second optical multi/demultiplexing circuit being connected to at least one of the outputs of the first optical multi/demultiplexing circuit.

85. (New) An optical multi/demultiplexing circuit comprising a first optical multi/demultiplexing circuit as defined in claim 79, and at least one second optical multi/demultiplexing circuit as defined in claim 79, the at least one second optical multi/demultiplexing circuit being connected to at least one of the outputs of the first optical multi/demultiplexing circuit.

86. (New) An optical multi/demultiplexing circuit comprising a first optical multi/demultiplexing circuit as defined in claim 80, and at least one second optical multi/demultiplexing circuit as defined in claim 80, the at least one second optical multi/demultiplexing circuit being connected to at least one of the outputs of the first optical multi/demultiplexing circuit.

87. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein the optical delay line device or the optical delay line include a path length difference adjusting device or undergoes path length adjustment.

88. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein the optical delay line device or the optical delay line include a birefringent adjustment device or undergoes birefringent adjustment.

89. (New) The optical multi/demultiplexing circuit as claimed in claim 57, wherein the optical multi/demultiplexing circuit is composed of silica-based glass optical waveguides.

90. (New) An optical multi/demultiplexing circuit module comprising an optical multi/demultiplexing circuit as defined in claim 57 installed in a casing, and having optical fibers held by the casing carry out input and output of an optical signal to and from the optical multi/demultiplexing circuit.

91. (New) A method for designing an optical multi/demultiplexing circuit with a phase generating function, where the optical multi/demultiplexing circuit multi/demultiplexes a plurality of optical signals in a whole passband, the whole passband being configured with a plurality of passbands, the plurality of passbands being arranged on a wavelength-domain grid or an optical frequency-domain grid, centers of each of the plurality of passbands being located on the wavelength-domain grid or the optical frequency-domain grid, the optical multi/demultiplexing circuit comprising one or more optical multi/demultiplexing devices including at least one input section and a plurality of output sections; and at least one optical delay line device interposed between each of the optical multi/demultiplexing devices; at least one of the optical multi/demultiplexing devices or the optical delay line devices including a phase generating device that generates a wavelength-dependent or optical frequency-dependent phase Φ with respect to a wavelength or optical frequency of light over the whole passband of the optical multi/demultiplexing circuit, the method comprising:

determining a target wavelength-dependent phase $\Psi(\lambda)$ or a target optical frequency-dependent phase $\Psi(f)$, where the target phase $\Psi(\lambda)$ or $\Psi(f)$ is a phase required to set a wavelength period between the centers of the adjacent passbands which are located on the wavelength-domain grid or to set an optical frequency period between the centers of the adjacent passbands which are located on the optical frequency-domain grid, respectively; and

configuring the phase generating device such that the wavelength-dependent or optical frequency-dependent phase Φ generated by the phase generating device is equal to the target wavelength-dependent phase $\Psi(\lambda)$ or the target optical frequency-dependent phase $\Psi(f)$.

92. (New) The method of claim 91 wherein determining a target wavelength-dependent phase $\Psi(\lambda)$ or a target optical frequency-dependent phase $\Psi(f)$ comprises:

determining the target wavelength-dependent phase $\Psi(\lambda)$ such that a transmission characteristic of the optical multi/demultiplexing circuit in the whole passband is given by an equation as follows:

$$X(\lambda) = \sum_{q=0}^{N} x_q \exp\left\{-j2\pi q\left[\frac{\Delta L'}{\lambda} - \Psi(\lambda)\right]\right\}$$

where N represents the order of the optical multi/demultiplexing circuit, x_q represents the expansion coefficients, λ represents a wavelength, $\Psi(\lambda)$ represents a target wavelength-dependent phase which is required to set the wavelength period between the centers of the adjacent passbands on the wavelength-domain grid, and $\Delta L'(=\Delta L+\delta L)$ represents the optical path length difference of the optical delay line device including wavelength-dependent refractive index, where ΔL is a fixed value and δL is a minute optical path length difference, which is a variable changed according to the design of the phase generating device.

93. (New) The method of claim 91 wherein determining a target wavelength-dependent phase $\Psi(\lambda)$ or a target optical frequency-dependent phase $\Psi(f)$ comprises:

determining the target optical frequency-dependent phase $\Psi(f)$ such that a transmission characteristic of the optical multi/demultiplexing circuit in the whole passband is given by an equation as follows:

$$X(f) = \sum_{q=0}^{N} x_q \exp\left\{-j2\pi q\left[\frac{n\Delta L'}{c} f - \Psi(f)\right]\right\}$$

where N represents the order of the optical multi/demultiplexing circuit, x_q represents the expansion coefficients, n represents a frequency-dependent refractive index, c represents the speed of the light, f represents an optical frequency, $\Psi(f)$ represents a target optical frequency-dependent phase which is required to set the optical frequency period between the centers of the adjacent passbands on the optical frequency-domain grid, and $\Delta L'(=\Delta L+\delta L)$ represents the path length difference of the optical delay line device, where ΔL is a fixed value and δL is a minute optical path length difference, which is a variable changed according to the design of the phase generating device.

94. (New) The method of claim 91 wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two, and configuring the phase generating device comprises:

appropriately setting respective coupling ratios of the optical couplers and respective optical path length differences of the optical delay lines.

95. (New) The method of claim 92 wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two, and configuring the phase generating device comprises:

appropriately setting respective coupling ratios of the optical couplers and respective optical path length differences of the optical delay lines.

96. (New) The method of claim 93 wherein the phase generating device comprises (M + 1) optical couplers and M optical delay lines interposed between the optical couplers, where M is an integer equal to or greater than two, and configuring the phase generating device comprises:

appropriately setting respective coupling ratios of the optical couplers and respective optical path length differences of the optical delay lines.

97. (New) The method of claim 91 wherein determining a target wavelength-dependent phase $\Psi(\lambda)$ or a target optical frequency-dependent phase $\Psi(f)$ comprises:

fabricating an optical multi/demultiplexing circuit and measuring the transmission characteristic over the whole passband; and

determining the target wavelength-dependent phase $\Psi(\lambda)$ or the target optical frequency-dependent phase $\Psi(f)$, based on deviations of each passband centers from desired positions on the wavelength-domain grid or the optical frequency-domain grid.